What is claimed is:

1. A carrier recovery apparatus for use in a high-definition TV receiver, comprising:

an error compensating unit that is configured to combine a complex input signal with a frequency signal to generate a complex output signal, wherein the complex output signal includes an error reference signal;

a switching unit that is configured to output the complex output signal selectively between a first output path and a second output path based on a switch control signal;

a switch control signal generator that is configured to generate the switch control signal based on the presence or absence of a pilot signal in the complex output signal;

a second error detecting unit that is configured to receive the complex output signal from the first output path of the switching unit, and is configured to generate the frequency signal to compensate for an error in the complex output signal based on the pilot signal in the complex output signal; and

a first error detecting unit that is configured to receive the complex output signal from the second output path of the switching unit, and is configured to determine location of the error reference signal in the complex output signal based on a real part of the complex output signal, and is configured to generate the frequency signal based on the location of the error reference signal in the complex output signal.

2. The apparatus of claim 1, wherein the first error detecting unit comprises:

a field synchronization detector that is configured to determine location of a beginning and an end of the error reference signal based on the real part of the complex output signal; and

a frequency error measuring unit that is configured to measure a variation in a phase angle of the complex output signal based on the location of the beginning and the end of the error reference signal, and to generate the error signal based on the variation in the phase angle of the complex output signal, wherein the complex output signal is divided into frames, and wherein

the frequency error measuring unit is configured to generate the error signal for the frames of the complex output signal.

3. The apparatus of claim 2, wherein the frequency error measuring unit comprises:

a delayer that is configured to delay the period of the complex output signal by an amount *L* to generate a delayed complex data signal;

a conjugate signal generator that is configured to generate a conjugate representation of the complex data signal;

a first multiplier that is configured to multiply the delayed complex data signal by the conjugate representation of the complex data signal to generate a first multiplier output signal;

an imaginary-number-generator that is configured to generate an imaginary number portion of the first multiplier output signal;

a real-number generator that is configured to generate a reciprocal representation of a real number portion of the first multiplier output signal;

a second multiplier that is configured to multiply the imaginary number portion of the first multiplier output signal by the reciprocal representation of a real number portion of the first multiplier output signal to generate a second multiplication value;

an operation unit that is configured to generate an arctangent of the second multiplication value; and

a third multiplier that is configured to multiply the arctangent of the second multiplication value by a coefficient signal to generate the error signal.

4. The apparatus of claim 3, wherein the coefficient signal is generated by the equation 1/(2*π*L), wherein L is a length of a sample of the error reference signal sample.

5. The apparatus of claim 2, wherein the frequency error measuring unit generates the error signal using the following equation:

$$\Delta F = 1/(2*\pi*L)\ \tan^{-1}[\sum_{n=0}^{L-1} \mathrm{Im}\{y(n+L)\,y(n)^*\} / \sum_{n=0}^{L-1} \mathrm{Re}\{y(n+L)\,y(n)^*\}],$$

wherein $\Delta F$ is the error signal, $y(n)$ is the complex output signal, $y(n+L)$ is the complex data signal with a period that is delayed by an amount $L$, $y(n)^*$ is a conjugate signal of the complex output signal, and $L$ is a length of a sample of the error reference signal.

6. The apparatus of claim 1, wherein the second error detecting unit comprises:

a frequency-phase synchronization loop that is configured to generate frequency and phase error values based on the pilot signal in the complex output signal;

a loop filter that is configured to filter the frequency and phase error values; and

an oscillator that is configured to generate the frequency signal with a frequency that varies based on at least one of the filtered frequency and phase error values and the error reference signal.

7. The apparatus of claim 1, wherein the complex input signal is a vestigial sideband (VSB) signal that is represented as a complex number, and wherein the error reference signal is a PN63 signal in a field synchronization signal of the complex input signal.

8. The apparatus of claim 1, wherein the switching unit is configured to provide the complex output signal to the first error detecting unit when the switch control signal generator senses the pilot signal in the complex output signal, and to provide the complex output signal to the second error detecting unit when the switch control signal generator does not sense the pilot signal in the complex output signal.

9. The apparatus of claim 1, wherein the complex output signal comprises an initial output signal and subsequent output signals, and wherein the switching unit is configured to provide the initial output signal to the first error detecting unit and to provide the subsequent output signal to the second error detecting unit.

10. A carrier recovery apparatus comprising:

an error compensating unit that is configured to combine a complex input signal with a frequency signal to generate a complex output signal, wherein the complex output signal includes an error reference signal;

an error detecting unit that is configured to determine location of the error reference signal in the complex output signal based on a real part of the complex output signal, and is configured to generate an error signal based on the location of the error reference signal in the complex output signal; and

an oscillator that is configured to generate the frequency signal with a frequency that varies based on the error signal.

11. The apparatus of claim 10, wherein the error detecting unit comprises:

a field synchronization detector that is configured to determine location of a beginning and an end of the error reference signal based on the real part of the complex output signal; and

a frequency error measuring unit that is configured to measure a variation in a phase angle of the complex output signal based on the location of the beginning and the end of the error reference signal that is determined by the field synchronization detector, and is configured to generate the error signal based on the variation in the phase angle of the complex output signal.

12. The apparatus of claim 11, wherein the complex output signal is divided into frames, and wherein the frequency error measuring unit is configured to generate the error signal for each of the frames of the complex output signal.

13. The apparatus of claim 11, wherein the frequency error measuring unit generates the error signal based on the following equation:

$$\Delta F = 1/(2 * \pi * L)\ \tan^{-1}[\sum_{n=0}^{L-1} \mathrm{Im}\{y(n+L)\, y(n)^*\} / \sum_{n=0}^{L-1} \mathrm{Re}\{y(n+L)\, y(n)^*\}],$$

wherein $\Delta F$ is the error signal, $y(n)$ is the complex output signal, $y(n+L)$ is the complex output signal with a period that is delayed by an amount $L$,

$y(n)^*$ is a conjugate signal of the complex output signal, and $L$ is a length of a sample of the error reference signal.

14. The apparatus of claim 10, wherein the complex input signal is a VSB signal that is represented as a complex number, and wherein the error reference signal is a PN63 signal in a field synchronization signal of the complex input signal.

15. A circuit for measuring an error in a complex data signal, comprising:

a field synchronization detector that is configured to determine location of a beginning and an end of an error reference signal in the complex data signal based on a real number representation of the complex data signal; and

a frequency error measuring unit that is configured to measure a variation in a phase angle of the complex data signal based on the location of the error reference signal in the complex data signal, and is configured to generate an error signal based on the variation in the phase angle of the complex data signal.

16. The circuit of claim 15, wherein the complex data signal is divided into frames, and wherein the frequency error measuring unit is configured to generate the error signal for each frame of the complex data signal.

17. The circuit of claim 15, wherein the frequency error measuring unit comprises:

a delayer that is configured to delay the period of the complex data signal by an amount $L$ to generate a delayed complex data signal;

a conjugate signal generator that is configured to generate a conjugate representation of the complex data signal;

a first multiplier that is configured to multiply the delayed complex data signal by the conjugate representation of the complex data signal to generate a first multiplier output signal;

an imaginary-number generator that is configured to generate an imaginary number portion of the first multiplier output signal;

a real-number generator that is configured to generate a reciprocal representation of a real number portion of the first multiplier output signal;

a second multiplier that is configured to multiply the imaginary number portion of the first multiplier output signal by the reciprocal representation of the real number portion of the first multiplier output signal to generate a second multiplication value;

an operation unit that is configured to generate an arctangent of the second multiplication value; and

a third multiplier that is configured to multiply the arctangent of the second multiplication value by a coefficient signal to generate the error signal.

18. The circuit of claim 17, wherein the coefficient signal is generated by the equation 1/(2*π*L), wherein L is a length of a sample of the error reference signal sample.

19. The circuit of claim 15, wherein the frequency error measuring unit generates the error signal using the following equation:

$$\Delta F = 1/(2*\pi*L)\ \tan^{-1}[\sum_{n=0}^{L-1} \mathrm{Im}\{y(n+L)\, y(n)*\} / \sum_{n=0}^{L-1} \mathrm{Re}\{y(n+L)\, y(n)*\}],$$

wherein *ΔF* is the error signal, *y(n)* is the complex data signal, *y(n+L)* is the complex data signal with a period that is delayed by an amount *L*, *y(n)** is a conjugate representation of the complex data signal, and *L* is a length of a sample of the error reference signal.

20. The circuit of claim 15, wherein the complex data signal is a VSB signal that is represented by a complex number, and wherein the error reference signal is a PN63 signal in a field synchronization signal of the complex data signal.

21. A method of recovering a carrier in a complex high-definition TV signal, the method comprising:

detecting the presence or absence of a pilot signal in the complex high-definition TV signal; and

selecting between performing a first error detecting function on the complex high-definition TV signal and performing a second error detecting function on the complex high-definition TV signal based on the detected presence or absence of the pilot signal in the complex high-definition TV signal.

22. The method of claim 21, further comprising combining the complex high-definition TV signal with a frequency signal to generate a complex output signal, wherein the complex output signal includes an error reference signal, and wherein the performing a first error detecting function comprises:

determining location of the error reference signal in the complex output signal based on a real part of the complex output signal;

generating an error signal based on the location of the error reference signal in the complex output signal; and

generating the frequency signal with a frequency that varies based on the error signal.

23. The method of claim 22, wherein the performing a first error detecting function comprises:

determining location of a beginning and an end of the error reference signal based on the real part of the complex output signal;

measuring a variation in a phase angle of the complex output signal based on the location of the beginning and the end of the error reference signal; and

generating the error signal based on the variation in the phase angle of the complex output signal.

24. The method of claim 22, wherein the performing a first error detecting function comprises:

delaying the period of the complex output signal by an amount *L* to generate a delayed complex output signal;

generating a conjugate representation of the complex output signal;

multiplying the delayed complex output signal by the conjugate representation of the complex output signal to generate a first multiplier output signal;

multiplying an imaginary number portion of the first multiplier output signal by a reciprocal representation of a real number portion of the first multiplier output signal to generate a second multiplication value;

generating an arctangent of the second multiplication value; and

multiplying the arctangent of the second multiplication value by a coefficient signal to generate the error signal.

25. The method of claim 24, wherein the coefficient signal is generated by the equation 1/(2*π*L), wherein L is the length of a sample of the error reference signal.

26. The method of claim 22, wherein in (b2) the error signal is generated using the following equation:

$$\Delta F = 1/(2*\pi*L)\ \tan^{-1}[\sum_{n=0}^{L-1} \mathrm{Im}\{y(n+L)\,y(n)^*\} / \sum_{n=0}^{L-1} \mathrm{Re}\{y(n+L)\,y(n)^*\}],$$

wherein *ΔF* is the error signal, *y(n)* is the complex output signal, *y(n+L)* is the complex output signal with a period that is delayed by an amount *L*, *y(n)** is a conjugate representation of the complex output signal, and *L* is a length of a sample of the error reference signal.

27. The method of claim 22, wherein the complex output signal is a VSB signal that is represented as a complex number, and wherein the error reference signal is a PN63 signal in a field synchronization signal of the complex high-definition TV signal.

28. The method of claim 21, wherein the performing a second error detecting function comprises:

determining frequency and phase errors in the pilot signal in the complex high-definition TV signal;

filtering the frequency and phase errors; and

generating the frequency signal based on the filtered frequency and phase errors.

29. A method of recovering a carrier in a complex high-definition TV signal, the method comprising:

combining the complex high-definition TV signal with a frequency signal to generate a complex output signal, and wherein the complex output signal includes an error reference signal;

determining location of the error reference signal in the complex output signal based on a real part of the complex output signal;

generating an error signal based on the location of the error reference signal in the complex output signal; and

generating the frequency signal with a frequency that varies based on the error signal.

30. The method of claim 29, wherein determining location of the error reference signal in the complex output signal comprises:

determining location of a beginning and an end of the error reference signal based on the real part of the complex output signal; and

measuring a variation in a phase angle of the complex output signal based on the location of the beginning and the end of the error reference signal; and

generating the error signal based on the variation in the phase angle of the complex output signal.

31. The method of claim 30, wherein the error signal is generated by the following equation:

$$\Delta F = 1/(2*\pi*L)\ \tan^{-1}[\sum_{n=0}^{L-1}\mathrm{Im}\{y(n+L)\,y(n)^*\}/\sum_{n=0}^{L-1}\mathrm{Re}\{y(n+L)\,y(n)^*\}],$$

wherein $\Delta F$ is the error signal, $y(n)$ is the complex output signal, $y(n+L)$ is the complex output signal with a period that is delayed by an amount $L$, $y(n)^*$ is a conjugate representation of the complex output signal, and $L$ is a length of a sample of the error reference signal.

32. The method of claim 29, wherein the complex high-definition TV signal is a VSB signal that is represented by a complex number, and wherein the error reference signal is a PN63 signal in a field synchronization signal of the complex high-definition TV signal.